

II.—*Note on the preceding paper.*—By H. B. MEDLICOTT, ESQ.,  
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Mr. Campbell has kindly permitted me to add a few words to his communication, to bring out a small residuum of difference that remains between us upon the question of a former greater extension of ice action in the Himalayas. On the wider question of the Ice Cap, I would only say that I have not understood that speculation as dispensing with local centres of accumulation and dispersion, as requiring the polar ice to have poured over the Himalayas. On the smaller question too, Mr. Campbell has taken up the comparatively easy task of confuting the most extreme opinion. Although there is no mention of names, it is plain that the paper just read is a refutation of Mr. Theobald's *Ancient Glaciers of the Kangra District*, with a copy of which I had lured Mr. Campbell into visiting that region. I had thought indeed that I had myself said all that was called for in answer to Mr. Theobald, by pointing out that his so called moraines were only ridges of erosion out of a diluvial deposit that must once have filled the whole valley (*Rec. Geol. Survey, Vol. IX, p. 56*) ; Mr. Campbell has, however, saved us any further trouble on that score by rehearsing all the well-known signs and tokens that must be left by a heavy glacier, and finding them wanting. In this he has entirely confirmed my own observations.

I was the first (fourteen years ago, *Mem. Geol. Survey, Vol. III, p. 155*) to bring to notice the big stones of the Kangra valley as probably due to ice. I would beg leave to quote the few words I gave to the subject :

“The most interesting of these deposits is that in which large erratic blocks occur so abundantly along the base of the Dhaoladhar. It first shows itself on the east, about Haurbaug, and is nowhere more strikingly seen than along the steep inner slopes of the duns east of Dhurmsala, where the huge blocks are thickly scattered over the surface. In viewing this deposit as the result of glacial action, I base my opinion chiefly upon the size of the blocks (I measured one twenty-five feet by eighteen, by ten) and upon some peculiarities of distribution. An eye more practised than mine in glacial phenomena might detect more direct evidence, but it certainly is not well-marked, and it is easy to account for the subsequent removal of all such traces of glacial action in such a position as this. The blocks occur at a present elevation so low as 3,000 feet above the sea-level, and they are found through fully a thousand feet in height. They are almost exclusively composed of the granitoid gneiss of the central mass of the Dhaoladhar, from which their area of distribution is separated by a

lofty ridge of schists, through deep gorges in which they have evidently been conveyed, a huge block being occasionally found perched on the sides of these gorges, some hundred feet above the present level of the stream; yet in such places I failed to observe any groovings or roundings of the rocky sides. The absence of evidence of this kind may, perhaps, be attributed to the rapidly disintegrating action of the heavy rains. I was many times puzzled to account for the positions in which these erratic blocks occur. They are frequently found on the slopes of the range out of the way of any of these main gorges, and even up the little receding valleys of streams, which only drain the outer hills, and down which the blocks could not have come. Must we superadd the agency of floating ice? The total absence of erratic blocks in other positions is often equally puzzling. The position of this glacial deposit more to the west, in the confined and elevated longitudinal valleys between Sihunta and Choari, impresses one more forcibly with the antiquity of its origin; it there lies in gaps and on ledges a full thousand feet over the deep drainage gullies close by."

Thus I adopted the opinion while declaring the absence of the usual scorings, and trusting to the facts of great size and peculiar distribution. The first step was an appeal against negative evidence, based upon the possible obliteration of superficial markings, by weathering and attrition, and upon the fact that although it is quite true that a *large glacier* must score its bed and the stones that lie thereon, transport by ice occurs largely without any such marks being made. We have recently had in India, and in this very connection of ice-action, a striking illustration of the unworthiness of such negative evidence. In 1856, Mr. W. T. Blanford declared his conviction that the Talchir boulder-bed was of glacial origin. Every year subsequently one or more of the officers of the Geological Survey were engaged upon these rocks in various parts of India, and looking out for evidence for or against this judgment, yet it was not till 1872 that Mr. Fedden had the fortune to find a most complete case of striated and polished Talchir boulders resting on a scored rock-surface. There are good specimens of these scratched boulders now in the Indian Museum. I have placed a small one on the table for inspection. In the case of the Kangra boulders, any possible glaciers in the Dhaoladhar must have been short, and have had a very rapid discharge; and consequently were of inconsiderable thickness, conditions which would reduce the scoring action to a minimum.

As to direct evidence, the matter of size of the blocks is of course conditional. On an appropriate slope masses of any dimensions may be moved with very little effort. If these Kangra big stones are, as Mr. Campbell contends, solely torrential deposits from the mountain gorges, we have only to work that simple condition so as to account for them wherever found. It is here that a slight discrepancy occurs between Mr.

Campbell's observations and mine. He describes having taken a walk of eleven miles, and found no big stones in some minor gorges draining only from the outer ridges. Relying on this single observation, and perhaps also upon the privilege he claims as a non-professional geologist, Mr. Campbell eliminates and ignores what I have from the first said to be the chief argument for glacial action, that large blocks of the gneiss from the central ridge do frequently occur away from the gorges leading from that ridge, in minor valleys draining only from the outer ridge, where it is most difficult to suppose they can have been placed in the manner he supposes. It was to account for the position of these blocks that I had to imagine their transport on ice-rafts. Instead, however, of insisting on this crucial point, which Mr. Campbell ignores or denies, I am prepared to suggest how it may be compatible with the view he adopts. The fact that coarse diluvial deposits, not derivable from the Sivaliks, are found high over Kangra fort, on the hills south of the valley, makes it certain that the whole valley was once filled with like deposits, which must have reached high along the base and far up the gorges of the Dhaoladhar. It may be that under such conditions the diluvial spill from the gorges was high enough to mantle round and over spurs and to fill little valleys that are now totally cut off from those gorges.

It would be impossible to estimate the plausibility of this supposition without testing it on the ground in view of actual features. At the same time I think that Mr. Campbell can only make out a Scotch verdict of 'not proven' for the ice, as deeply implicated in the transport of these big stones. I cannot bring myself to doubt the evidence that has been given for the former extension of the great Himalaya glaciers to 4,000 feet lower than they at present attain to, as observed by Dr. Hooker, and by Mr. W. T. Blanford in Sikkim. At that time ice-agency must have been very active on the Dhaoladhar. If at present, as Mr. Campbell testifies, lumps of ice are brought by the torrents to the mouth of the gorges, the lumps of those days were probably large enough to pick up the big stones in their way. I would further suggest for Mr. Campbell's consideration, that so far as we can at present estimate it, the age of these high-level gravels along the base of the Himalayas, and to which the Kangra deposits belong, seems to be closely coincident with that of the Ice-Age of the western continents. An increase of glacial conditions in the Alps, corresponding to that proved for the Himalayas in Sikkim, would probably bring the ice down to Interlaken, if not to Neufchatel.

I would conclude these few remarks with the hope that among the many settlers in the Kangra valley, there may be some members of this Society who will study the ground they live upon with some other purpose besides the cultivation of tea.

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